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Senior High School

CURRICULUM GUIDE

Vocational Series

MACHINE SHOP 12 - 22 - 32

(Interim Edition, September 1963)

Province of Alberta

Department of Education

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COURSE CREDIT VALUES

Machine Shop 12	5 credits
Machine Shop 22	15 credits
Machine Shop 32	15 or 20 credits

One credit corresponds to a minimum of 40 minutes of instruction time per week.

FOREWORD

Man has been working metal for thousands of years. He has progressed from the time that he replaced his stone axes and spears with bronze weapons up through the Iron Age and into the Age of Machines. The Machine Age began about 300 years ago when man began to learn how to use sources of power other than his own brute strength and that of his animals. He invented new machines, used the power of the wind, the water and coal to operate them and save his back in the process.

Most everything that is produced today whether it be for food, clothing or shelter is processed by machines. Today's machines have developed far beyond the simple application of steam power and the use of levers to control the machines. The machines of today are electronically operated by pushbuttons. In order to operate the machines of today, skilled technicians, not just machine operators are indispensable. Such men must be capable of interpreting and carrying out ideas that call for the production of new and extremely intricate parts. In addition to skill, they must possess knowledge, judgment, confidence, orderliness and safe work habits before they can be considered to be skilled craftsmen. More and more of the repetitive skills are being done by machine. The machinist today must work more and more with his head. Knowing the "why" has become just as important as knowing "how" to do the job.

GENERAL OBJECTIVES

1. To impart to the student, a knowledge of the role the machinist plays in industry and the opportunities that exist in this field.

2. To equip a student with sufficient skill and knowledge such that he will be highly employable in the machinist trade.

3. To enable a student, entering the machinist apprentice program, to advance at an accelerated rate on the basis of his proven ability on the job.

4. To prepare a student to a degree of competency acceptable to the Institutes of Technology, sufficient for entry into the second year of the Mechanical Technology program.

SPECIFIC OBJECTIVES

1. To enable students to operate power machines efficiently, accurately and safely.

2. To acquaint students with the basic types, features and functions of machinery used in the machinist trade.

3. To develop desirable habits concerning safety, good working relationships, and proper use of time and material.

4. To develop high standards of workmanship.

5. To familiarize students with the principles and practices involved in accurate measuring and working to close tolerances.

6. To develop the skills and knowledge required to interpret blueprints accurately as well as to produce accurate drawings.

7. To familiarize students with the different types of metal used in industry.

GENERAL INFORMATION

1. Course Credit Values

Machine Shop 12 - 5 credits
Machine Shop 22 - 15 credits
Machine Shop 32 - 15 or 20 credits

NOTE: 5 credits of drafting are included in each of Machine Shop 22 and 32.

2. Time Allocation

It is recommended that in the Machine Shop 12, 22 and 32 courses, one-third of the time be given to theory and two-thirds to shop practice.

3. Safety Program:

Every shop must have an effective safety program. In the machine shop, particular attention must be given to the safety measures required in the industry: adequate guards; cleanliness of shop and personnel maintained at a high standard; students properly clothed for their work; etc. Shop organization must be such as to ensure stressing this very important phase of the shop program.

A good safety program features the following devices: regular, consistent and thorough instruction; constant vigilance and checking by the instructor; safety posters; student safety committee; adequate first aid equipment; instructor trained and up-to-date in first aid methods; dynamic color painting of machines and equipment; adequate working space about machines; safety lines on floor around machines; routine report on accidents however minor; machines and tools in approved working condition; a safety-conscious group of students and instructor.

4. Instructor's Records

The instructor should keep accurate records of:

a. student enrolment and attendance
b. student accounts
c. student work activity
d. theory covered
e. tests given
f. student achievement
g. up-to-date inventory of all equipment

5. Student Records

Instructors should ensure that the student develops and maintains a neat and accurate record of:

a. notes on theory
b. daily shop activities (time cards)

6. Enrolment

The recommended enrolment for machine shop classes is 16 students and under no conditions should it be allowed to increase beyond 20. Two classes may easily be combined for the presentation of theory.

7. Guidance and Vocational Information

Instructors must assume responsibility in their trade area to ensure that students and school guidance officials are aware of the local situation. It is essential that the instructors be active, interested and informed regarding the opportunities in the trade.

NOTE: In order to permit students from an academic Grade X program to cross over into the vocational program at the Grade XI level, schools may combine the 12 and 22 courses into one course for a total of 20 credits. Where these courses are combined it is recommended that students purchase the Grade XI text only.

8. Projects

It is expected that some projects will be used in Grade X and to a limited degree in Grades XI and XII as vehicles of instruction and as a means of securing and retaining student interest. The onus is on the instructor to ensure that the projects selected involve only those operations specified in the course outline, and that the time required to complete the project does not encroach upon the time needed to learn other skills and operations.

INSTRUCTIONS ON THE USE OF THE FOLLOWING OUTLINE

The course outline is divided into three columns designated: Operations, Basic Information and References. The first column outlines the type of activity performed by the students in the shop. The second column refers to the essential knowledge upon which a well educated employee in the machine industry will depend to adequately carry out the operations outlined in the first column. It includes knowledge of a general nature regarding the trade and the industry, that is not directly related to the operations. The third column lists numbers which correspond to references other than the prescribed texts. The references are listed in the back of the curriculum guide. The reference column is not considered to be complete. Instructors are requested to insert references which they consider most suitable for the particular topics outlined. It would be desirable if insturctors would also note the time spent on the various units. This information will be extremely valuable to the curriculum committee in revising this outline. We ask that instructors keep two copies of this guide, one of which can be returned to the Department with the instructor's notations as mentioned above and one for the instructor's own records.

The authorized text for Machine Shop 12 is MACHINE SHOP THEORY AND PRACTICE by F. H. Hallett and published by the Macmillan Company of Canada Limited.

The authorized text for Machine Shop 22 and 32 is MACHINE TOOL METALWORKING by Feirer and Tatro and published by the McGraw-Hill Company of Canada.

NOTE: Whereas the Machine Shop 12 course is an exploratory course open to all Grade X students, the Machine Shop 22 and 32 courses are definitely vocational and only those students who have displayed ability and aptitude for the program should be encouraged to continue. It is not fair to the student to permit him to continue in a program which demands a large portion of his school time, and in which the instructor and/or the guidance counsellor feel that he has little chance of success.

OBJECTIVES FOR MACHINE SHOP 12

The machine shop course in Grade X is considered to be exploratory in nature. The knowledge and experience gained should enable the student to make an informed decision in regard to his possible future in this field.

More specifically, the objectives for Machine Shop 12 are as follows:

1. To impart occupational information related to the opportunities in the machine industry.
2. To develop basic skills in the care and safe use of hand and power tools and equipment.
3. To learn and provide opportunity for the students to practice the correct and safe procedures involved in operating the lathe, power saw, drill press, grinder and shaper.
4. To learn the different types of metal and their uses in regard to machine work.

MACHINE SHOP 12 OUTLINE

Unit I: The Machinist Trade

Operations	Basic Information	References
Familiarization tour of the shop; outline shop procedure and routine.	Types of work, working conditions, opportunities for employment and advancement; the Apprenticeship Program; Institutes of Technology Programs.	1, 2, & 3

Unit II: Layout Work

Lay out work using the tools and instruments listed to the right.	Layout tools and instruments, their description and use; scriber, dividers, combination set, steel rule, layout fluid, center punch, ball peen hammer, prick punch, steel square, hermaphrodite caliper, surface plate.	

Unit III: Bench Work

Sometimes it is impossible, inconvenient, or inefficient to shape stock on power machinery. Consequently, it is important for machinists to develop the skills required for bench metal work. The purpose of this unit is to acquaint pupils with the tools commonly used in bench work and their correct uses.

Hammering	Types, features and applications of hammers, e.g., machinist's, riveting, soft, mallets.	
Chiselling	(a) Safe practices, e.g., the use of goggles and the removal of mushroom heads. (b) Types, features, and applications of chisels, e.g., cold, cape, side, diamond. (c) Correct chiselling procedures.	
Punching	Features and uses of various punches, e.g., solid, center, prick, drift, aligning.	

Operations	Basic Information	References
Sawing	(a) Types, features, and applications of hack saw blades.	
	(b) Correct usage of the hack saw on various thicknesses and kinds of material.	
Filing	(a) Nomenclature and selection of files.	
	(b) Principles and techniques of filing, including draw filing.	
Drilling on the drill press	(a) Sizes and specifications of drills.	
	(b) Methods of holding stock while drilling.	
	(c) Methods of drilling holes using hand and portable power drills and drill press.	
	(d) Countersinking methods.	
Hand tapping and external threading	(a) Hand tools - wrenches, screwdrivers.	
	(b) Types, features and application of standard screw threads.	
	(c) Screw thread calculations, e.g. pitch, diameter, tap drill size, etc.	
	(d) Methods of holding and driving hand taps.	
	(e) Precautions concerning tap breakage.	
	(f) Methods of holding and driving dies.	
	(g) Cutting oils.	

Operations	Basic Information	References
Fitting	(a) Common metal fasteners and their uses, e.g. bolts, nuts, screws, rivets, keys, taper pins, etc.	
Polishing Metal	(a) Types and functions of abrasive materials such as stones, powders and cloths. (b) Correct procedures.	
General Work	(a) Methods of holding work, e.g. vises, clamps, jigs, stops, fences. (b) Safety principles and practices.	
Unit IV: Metallurgy		
	Competence in machine shop work requires some ability and understanding in metallurgy. Instruction should cover the following topics:	
	(a) Common metals.	
	(b) Production of iron and steel.	
	(c) Identification of metals.	
	(d) Properties and uses of metals.	
	(e) Heat treatment, principles, procedures and applications.	

Operations	Basic Information	References
Unit V: Lathe Work		
Trueing up work, facing or squaring, parallel turning, parting, chuck turning, turning between centers, drilling, tapping, using the micrometer caliper.	(a) Parts of the machine, their features and their functions.	
	(b) Methods of mounting work.	
	(c) Types, features, functions and limitations of chucks.	
	(d) Methods of trueing up work.	
	(e) Features and functions of measuring and testing tools, e.g. calipers, micrometer, gauges, indicators.	
	(f) Selection and control of speeds and feeds.	
	(g) Types and lathe tools, their design and their function.	
	(h) Methods of mounting cutting tools.	
	(i) Safety principles and practices.	
Center drilling, drilling	(a) Types, features and functions of drills.	
Filing	(a) Types of files and their uses.	
Polishing	(a) Kinds of abrasive materials and their uses.	
	(b) Types of lathe tools, their designs and functions.	
Taper turning	(a) Types, features and functions of tapers.	
Cutting V threads	(a) Taper settings in degrees.	

Operations	Basic Information	References
Unit VI: Power Sawing		
Sawing different kinds, shapes and thicknesses of materials	(a) Types, features and functions of power saws.	
	(b) Principles and practices in operating power saws.	
	(c) Methods used in holding various sizes and shapes of materials, e.g. long and short bars, angle iron, tubing.	
	(d) Coolant.	
	(e) Safety principles and practices.	
Unit VII: Drill Press Work		
Drilling, drilling for tapping purposes; countersinking; boring; reaming	(a) Parts of the machine and their functions.	
	(b) Uses of vises, stops and clamps.	
	(c) Uses of chucks, sockets and sleeves in holding drills.	
	(d) Types, features, sizes, and functions of drills.	
Demonstration of drill grinding	(a) Principles and practices in grinding drills.	
	(b) Selection of speeds and feeds.	
	(c) Production methods.	
	(d) Methods of measuring, testing and gauging.	
	(e) Coolants and cutting oils and their uses.	
	(f) Safety principles and practices.	

Operations	Basic Information	References
Unit VIII: Grinding		
Grinding hand tools such as chisels, screwdrivers, scribers and center punches.	(a) Types, features and functions of abrasives and grinding wheels.	
	(b) Tool designs for various machines and operations.	
	(c) Taking care of the grinding wheel surface.	
	(d) Safety principles and practices.	
Dressing a grinding wheel (Demonstration only).	(a) Types of wheel dressers and the techniques involved in using them.	

Special Note

This course has a total credit value of 15 and is broken down as follows:

1. Machine shop practice and theory - 10 credits.
2. Mechanical drafting (part 1) - 5 credits.

The outline for Drafting 12 should be used as the content for the mechanical drafting mentioned above.

In those schools where the machine shop students have already completed Drafting 10 or 12 in Grade X, the time for drafting may be reduced considerably and limited to a review of Drafting 12 theory, and practice to improve drafting skills.

Under no circumstances should the drafting portion be deleted as a result of the student having taken Drafting 10 or 12. Where the drafting time is reduced in keeping with the above instructions, the additional time gained should be spent in machine shop practice.

MACHINE SHOP 22 OUTLINE

Operation	Basic Information	References
Unit I: Layout Work		
Laying out exercises or projects using the tools and instruments listed on the right.	(Review) Layout tools and instruments, their description and use: steel rule, layout fluid, scriber, dividers, combination set, center punch, prick punch, ball peen hammer, steel square, hermaphrodite caliper, surface plate, C-clamp, trammel, vernier height gauge, bell cup punch.	
Unit II: Bench Work		
Hammering	(a) Types, features and applications of hammers, e.g. machinist's, riveting, soft, mallets.	
Chiselling	(a) Safety practices concerning, e.g. the use of goggles and the removal of mushroom heads. (b) Types, features and applications of chisels, e.g. cold, cape, side, diamond. (c) Correct chiselling procedures.	
Punching	(a) Features and uses of various punches, e.g. solid, center, prick, drift, aligning.	
Sawing	(a) Types, features and applications of hack saw blades. (b) Correct usage of the hack saw on various thicknesses and kinds of material.	

Operations	Basic Information	References
Filing	(a) Nomenclature and selection of files.	
	(b) Principles and techniques of filing, including draw filing.	
Drilling	(a) Sizes and specifications of drills.	
	(b) Methods of drilling holes using hand and portable power drills.	
	(c) Countersinking methods.	
Reaming	(a) Types, features, and uses of hand reamers, e.g. solid, adjustable, expansion.	
	(b) Allowances for reaming.	
Tapping and External Threading	(a) Types, features and application of standard screw threads.	
	(b) Screw thread calculations, e.g. pitch, diameter, tap drill size, etc.	
	(c) Methods of holding and driving hand taps.	
	(d) Precautions concerning tap breakage.	
	(e) Methods of holding and driving dies.	
Fitting	(a) Common metal fasteners and their uses, e.g. bolts, nuts, screws, rivets, keys, taper pins, etc.	
	(b) Techniques of fitting keys, cotters, shafts, gears, bearings, etc.	

Operations	Basic Information	References
Honing, lappings, and polishing	(a) Types and functions of abrasive materials such as stones, powders, cloths and buffing wheels.	
	(b) Correct procedures.	
General Work	(a) Methods of holding work, e.g. vises, clamps, jigs, stops and fences.	
	(b) Safety principles and practices.	
Unit III: Hot Metal Work		
Forging	(a) Furnaces, tongs, anvils, hammers, forging procedure.	Machine Shop 12 Text 2
Heat treating of tools and projects	(a) Hardening of carbon and alloy steels, tempering, annealing, normalizing, case hardening.	2
Work in general	(a) Safety principles and practices.	
	(b) Habits needed in taking care of the machine.	
	(c) Uses of cutting oils and coolants.	
Faceplate Work	(a) Types, features and functions of faceplates and faceplate fixtures.	
	(b) Layout procedures.	
	(c) Principles and practices in counterbalancing.	

Operations	Basic Information	References
Work requiring the use of the steady rest and follower rest	(a) Types, features and functions of steady rests and follower rests. (b) Procedures in the use of steady rests.	
Knurling	(a) Types, features and functions of knurling tools. (b) Knurling procedures. (c) Selection of speeds and feeds.	
Taper turning and boring	(a) Types, features and functions of tapers. (b) Taper calculations. (c) Methods of testing and measuring tapers. (d) Tools, devices and methods for boring inside tapers. (e) Types, features and uses of surface high spot indicators, e.g. mechanic's blue, red lead, alcohol. (f) Uses of freehand boring and scraping tools. (g) Relationship of bore size to boring bar. (h) Uses of the arbor press.	

Operations	Basic Information	References
Screwcutting right and left hand external and internal threads	(a) Thread nomenclature and terminology.	
	(b) Specifications of U.N.C., U.N.F., and N.P. threads.	
	(c) Types and features of single point threading tools and chasers.	
	(d) Methods of measuring and gauging screw threads and threading tools.	
	(e) Gear calculations.	
	(f) Ratios.	
	(g) Types and uses of thread indicators.	
	(h) Methods of selecting and setting the lead for threading.	
	(i) Methods of cutting threads without a chasing dial.	
Turning and forming contours	(a) Methods used in turning and forming contours, freehand and form tool.	
	(b) Types and applications of forming tools.	
	(c) Methods of testing and measuring contours.	
Work in general	(a) Safety practices and principles.	
	(b) Habits required in taking care of the lathe.	
Turning on mandrels and collet chucks	(a) Types of mandrels.	
	(b) Mounting the work and turning procedure.	

Operations	Basic Information	Referemces
Unit V: Milling		
Work in general	(a) Safety principles and practices.	
	(b) Habits needed in taking care of the machine.	
	(c) Uses of cutting oils and coolants.	
Milling horizontal and vertical flat surfaces; milling keyways and slots; end milling	(a) Features and functions of different types of milling machines.	
	(b) Types, features, uses of cutters, attachments and accessories.	
	(c) Features and functions of control mechanisms.	
	(d) Selection of speeds and feeds.	
	(e) Methods of mounting cutters, attachments and accessories.	
	(f) Methods of holding the work, e.g. vises, auxiliary tables, centers, angle plates, rotary tables.	
	(g) Methods of milling to a shoulder.	
Unit VI: Grinding	(h) Testing and gauging methods.	
Work in general	(a) Safety principles and practices.	
	(b) Habits needed in taking care of the machine.	

Operations	Basic Information	References
Grinding a plane surface	(a) Types, features and functions of grinding machines.	
	(b) Methods of holding the work, e.g. vises, chucks.	
	(c) Selection of suitable wheels.	
	(d) Selection of speeds and feeds.	
	(e) Methods of keeping the work square.	
	(f) Types, features and functions of precision measuring instruments.	
Tool grinding	(a) Types, features and characteristics of various tool materials.	
	(b) Recognition of and tests for various tool materials.	
	(c) Types, features and characteristics of tools for various jobs and materials.	
	(d) Tool design, profile and angles for roughing and finishing.	
Drill grinding	(a) Drill terminology and nomenclature.	
	(b) Types and features of drill grinding fixtures.	
	(c) Instruments and methods for testing drills.	

Operations	Basic Information	References
Unit VII: Shaping		
Work in general	(a) Safety principles and practices.	
	(b) Habits needed in taking care of the machines.	
	(c) Parts of the machine and their functions.	
Shaping horizontal, vertical and angular flat surfaces	(a) Tool designs and functions.	
	(b) Methods of mounting tools for internal work.	
	(c) Precautions concerning feeds in confined areas.	
	(d) Methods of mounting work.	
	(e) Methods of cutting to a shoulder.	
	(f) Calculations for angles to be shaped.	
	(g) Methods of making starting holes for internal shaping, e.g. drilling, burning.	
	(h) Types and features of measuring and testing tools.	
Shaping external keyways	(a) Layout techniques.	
	(b) Selection of tools.	
	(c) Types and standards for keyways.	
Serrating a flat surface	(a) Purposes of serrating surfaces.	
	(b) Types and features of serrating tools.	
	(c) Speeds and feeds for serrating.	

MACHINE SHOP 32 - 15 or 20 CREDITS

Special Note:

This course has a total credit value of 15 or 20 and is broken down as follows:

1. Machine shop practice and theory - 10 or 15 credits.
2. Mechanical drafting (Part 2) - 5 credits.

MECHANICAL DRAFTING (Part 2) OUTLINE

Operations	Basic Information	References
Unit I: Lettering		
	Gothic capitals, numerals, and fractions. Freehand vertical.	
Use of cross-section paper or ruled squares (perhaps 1/2" or 3/4") for practice in forming letters of proper Gothic form, correct height in relation to width, and approved sequence of strokes.	1. Form and proportion. 2. Order of strokes.	
Lettering practice. Use thin faint guide lines for 1/4" and 1/8" letters and numerals. Students should have lettering instruments to make guide lines.	3. Uniformity in form, shape, height and stroke. Strokes dark, sharp, definite and of approved width.	
Practice for height and proportion in fractions and proper placement of bar.	4. Fractions - height of fractions in relation to whole numbers. Fraction bar is not oblique. Figures do not touch fraction bar.	

Operations	Basic Information	References
Lettering words and sentences 3/8", 1/4" and 1/8" high. Stress importance of extensive and careful practice.	5. Spacing letters and words.	
Learn and apply methods of centering words and phrases through exercises.	6. Simple titles and title blocks. 7. Meaning of "lightface" and "boldface" lettering.	
Assignments to include "lightface" and "boldface" lettering as well as compressed and extended letters.	8. Compressed and extended letters.	
Unit II: Instruments and Materials		
	A. Scales 1. Types - Architectural, Mechanical, Engineering and Civil Engineering with the uses of each.	
Scale a number of lines of given length to various scales.	2. Use of the commonly accepted scales.	
	3. Scale shapes and materials.	
	4. Methods of division. (a) open divided (b) close or chain divided	
	B. Pencils	
Students should purchase soft, medium and hard pencils. Demonstrate advantages and disadvantages of various pencils on various surfaces.	1. Hardness and grade. 2. Quality. 3. Composition of various pencils and where used. 4. Points and sharpening of pencils. 5. Mechanical pencils.	

Operations	Basic Information	References
Draw one plate of circles of specified sizes.	C. Compasses	
	1. How to adjust and their use.	
	2. Adjusting and using bow instruments.	
Problems involving the use of these instruments.	3. The drop compass.	
	4. The beam compass.	
	5. Sharpening the lead.	
	6. Adjusting and care of the pen.	
	D. Dividers	
Careful demonstration of the correct operations. Divide given lines and arcs into equal spaces. Transfer measurements from one drawing to another in combination with T-square and triangle practice.	1. Adjustment.	
	2. Transferring lengths.	
	3. Dividing lengths.	
	E. Parallel Ruling Devices	
Students should start with problems involving T-square and triangles, then advance to combination with "case instruments." Suggested projects - F & S p. 361, problems A.1 to A.6., A.13 to A.16 for straight line work, and problems A.6 to A.8, A.11 and A.17 for combined straight and curved lines. Problems A.23, p. 374 involves scale and triangles.	1. T-square - materials, testing, care of and correct use.	
	2. Parallel rule (cable type) testing, care of and correct use.	French and Svenson
	3. Drafting machines. Types (bond, parallelogram, rail mounted); adjustments, care and correct use.	
	4. Straight edges - types and uses.	
	5. Triangles, fixed, materials, testing, trueing and use.	
	6. Adjustable triangles, advantages and disadvantages, use of.	

Operations	Basic Information	References
	F. Irregular and Flexible Curves	
Practice to include plotting of ellipses or other non-circular curves; graphs; etc.	1. Irregular (French) curves - types, use of.	
	2. Flexible curves - adjustable and spline.	
	G. Protractors	
	1. Materials, shapes; plain and vernier.	
Layout angles.	2. Used to lay out angles.	
Measure angles on a problem sheet.	3. Used to measure angles.	
Students examine and draw on various types and grades of papers. Most assignments should be completed on tracing paper.	H. Paper - Types and Uses	
	1. Drawing papers.	
	2. "Natural" tracing papers.	
	3. "Prepared" tracing papers.	
	I. Drawing Boards and Covers	
	J. Erasing Devices - erasers, erasing shields, erasing machines.	
Unit III: Geometrical Construction		
Review through problems, basic constructions previously studied in Drafting (Part I).	A. Draftsman's methods applied to geometry.	French & Svenson p. 378-380.
	B. The function of geometrical constructions in solving drafting problems.	
	The mathematical reasoning in relation to problems, e.g. tangents in relation to arcs and ellipses, the ellipse of a conic section, loci, terms and definitions. The importance of these constructions in developing skill and precision in the use of instruments and sharp pencils.	F & S, p. 49-59.

Operations	Basic Information	References
	C. Geometrical Constructions	
Drawing assignments involving the new constructions listed.	1. Arc tangent to two arcs. 2. Ogee curve.	F & S p. 55-59
Drawing assignments and/or job sheets applying these construction to problems.	3. To rectify an arc. 4. Ellipse - trammel and concentric circle method. 5. Helix.	F & S p. 380
Unit IV: Theory of Projection		
	A. Systems of Projection	
	There are two classifications of projective systems, perspective or central projection and parallel projection.	Geisecke p. 10 (chart)
Students are not expected to make perspective drawings.	1. Perspective (a) one point (parallel) (b) two point (angular) (c) three point (angular)	F & S p. 198
	Instructor should not attempt to teach the theory of perspective but should limit this to illustrations of the various kinds of perspective teaching recognition of these types only.	
The information given by the instructor should be included in the student's notes complete with drawings of simple objects illustrating the kinds of parallel projection.	2. Parallel projection (a) The eye of the observer is at an infinite distance from the object. (b) The projectors are parallel. (c) Projectors pierce the picture plane at the same angle. (d) Types of parallel projection. 1. Orthographic (a) Multiview (b) Axonometric i. isometric ii. dimetric iii. trimetric 2. Oblique (a) Cabinet (b) Cavalier	

Operations	Basic Information	References
	B. Multiview Orthographic Projection	
	1. Third Angle	
Study chapter V of French & Svenson.	(a) Definition of orthographic projection.	F & S p. 64
	(b) Planes of projection. 1. Horizontal 2. Frontal 3. Profile	
Notes complete with sketches.	(c) Projectors are perpendicular to planes of projection.	G. pp. 159,160, 207, 208
	(d) "Glass box" principle.	
	(e) C.S.A. (A.S.A.) arrangement of views.	F & S pp. 65 - 66
	(f) Alternate positions.	
	(g) Principle of third angle projection - 4 quadrants.	
	(h) Representation of lines. 1. Edge view 2. Intersection 3. Surface limit	
Notes and drawings of very simple objects to illustrate these surfaces and edges as shown on the drawing.	(i) Classification of lines and surfaces. 1. Normal surfaces 2. Normal lines 3. Inclined surfaces and inclined edges 4. Oblique surfaces and oblique edges 5. Parallel edges 6. Curved surfaces 7. Cylindrical surfaces 8. Deformities of cylinders	G. pp. 173, 224 - 234
Students should draw samples of these lines or they could be incorporated into a drawing of a simple object. They should master the techniques of drawing good lines before proceeding to more difficult drawings.	(j) Line characteristics 1. Construction lines 2. Center lines 3. Outlines 4. Hidden lines	F. p. 41 G. pp. 20, 21 Z. p. 44 F. p. 102 Z p. 46 F & S, pp. 62-63

Operations	Basic Information	References
Notes	(k) Precedence of lines.	
	(l) The three space dimensions. 1. Height 2. Width 3. Depth	
	(m) Selection of views.	F & S, p. 171
Notes and exercises	(n) Spacing of views.	F & S, p. 94
Notes and a simple drawing using one method of spacing.		F. p. 106
	(o) Projecting the views.	
Study chapter VII of French & Svenson, Problems for drawing: D - 37, D - 38, D - 39, D - 40, D - 41, D - 50 (F & S)	1. Use of projectors	F. p. 107, 109
	2. Transferring measurements	
	3. Projecting an ellipical boundary.	G. p. 163-166, 210-213
	4. Projecting a curved boundary.	
Fundamentals i.e. layout, accuracy, neatness, correct line weights, lettering, etc., must be stressed at all times. The above exercises to be followed by a minimum of three drawings of actual objects.	(p) Order of drawing.	F. p. 110
	2. Multiview Drawings (First Angle)	G. p. 188, 243
Notes It is desired that students have a knowledge of this method only.	(a) Theory behind first angle.	
	(b) Quadrants used.	Z. p. 25
	(c) Where this kind of projection is used.	
Study of all of chapter IX, F & S.	3. Auxiliary View (Primary)	Z. p. 167
	(a) Definition of primary auxiliary.	
	(b) The auxiliary plane.	G. pp. 234, 235, 263, 264, 265
	(c) Folding lines.	
	(d) Reference planes.	
	(e) Direction of views and projectors.	
	(f) Transferring measurements.	
The theoretical portion of this subject should be covered in the student's notes complete with diagram.	(g) How to draw a primary auxiliary view. 1. Using a folding line 2. Using a reference plane	

Operations	Basic Information	References
	(h) Plotting curves, circles, etc.	
Problems F & S F1, F2, F4, F8, F9, F10. Fundamental techniques and methods must be stressed and checked at all times.	(i) Completing principle views from auxiliary views. (j) Hidden lines in auxiliary views. (k) Revolution. (l) Steps to follow in drawing a primary auxiliary view.	
	4. Sections	
Study complete chapter.	(a) Definition.	F & S, p. 98
	(b) Cutting plane and line.	F. p. 216
	(c) Full section.	G. pp. 213, 250 - 255
	(d) Half section.	
	(e) Section lining technique thin materials - outline sectioning, etc.	
	C. Axonometric (Gr. Axon - axle) (metric measure)	
Some fundamental instruction given here.	Types of axonometric projection; isometric, dimetric and trimetric.	G. pp. 481-482 F & S, 187
	1. Isometric Projection	
Free hand sketching.	(a) Isometric drawing.	Z. p. 193
Use simple drawing to obtain practice and stress importance of proper layout of drawing.	(b) Position of isometric drawing.	G. pp. 453-485, 486 F & S, pp. 187-188
	(c) Hidden lines in isometric drawings.	G. p. 486
	(d) Center line.	
	(e) Box construction.	
	(f) Dimensioning	G. p. 487
The students should do several drawings which include all of the above principles.	(g) Non-isometric lines, angles in isometric.	F & S, p. 189
	(h) Irregular objects.	G. p. 488
	(i) Circles in isometric; several simple drawings.	F & S, p. 190 G. p. 492
One drawing.	(j) Isometric sectioning.	G. pp. 494, 496
	D. Oblique Projection	
	1. Introduction	Z. p. 204
	(a) Define oblique projection.	F & S, pp. 514, 515, 516
	(b) Direction of oblique projection.	
	(c) Choice of position.	

Operations	Basic Information	References
Several simple cabinet drawings to illustrate advantages of cabinet drawing. Simple drawings of perhaps a cabinet and a cavalier drawing of the same object.	2. Cabinet Drawing (a) Define cabinet drawing. i. angle of projectors ii. length of receding lines	G. p. 516
	3. Cavalier Drawing (a) Define cavalier drawing. (b) Use of cavalier, limitation. i. angle of receding lines ii. length of receding lines	G. p. 517, 518
Unit V: Dimensioning		
	A. Introduction to Dimensioning	
	B. Systems of Dimensioning	F & S, p. 124
	1. Aligned system.	
	2. Unidirectional system.	
	3. Where used.	
	C. Placement of Dimensions	
Study chapter X, F & S.	1. Off views where possible.	G. pp. 298-309
	2. Between views.	
	3. Close to part affected.	F. p. 286-288
	4. On contour view.	
	5. Specified distance from views and from other dimensions.	
	D. Dimensioning of:	
	1. Prisms.	G. p. 311
	2. Cylinders.	
	3. Hexagons, octagons, etc.	
	4. Pyramids.	
	5. Circles.	
	6. Chamfers.	

Operations	Basic Information	References
	E. Geometric Breakdown	G. p. 309
	1. Size dimensions.	
	2. Location dimensions	F. p. 282
	F. Notes	
	1. Types and uses.	
	2. Placement of notes.	
Unit VI: Technical Sketching	A. Freehand Drafting (Multiview and Pictorial)	
	1. Purposes (a) Learning to read drawings and prints. (b) Describe parts. (c) Explaining production, assembly and operation in all fields of engineering.	
	2. Advantages of Technical Sketching (a) A greater freedom in drawing. (b) Quick convenient method of developing design ideas, shapes and arrangement of parts. (c) Providing quick descriptions and explanations for manufacture or other engineering or industrial purposes.	
Freehand lettering (review) Vertical Gothic Upper Case letters, numbers.	3. Materials for Sketching (a) Pencils. (b) Erasers. (c) Papers.	
Exercises in drawing these lines followed by geometric figures and finally simple objects in orthographic and pictorial sketching.	4. Freehand Sketching (a) Horizontal lines. (b) Vertical lines. (c) Slant lines. (d) Quality of lines. (e) Circles and arcs. (f) Tangents. (g) Proportioning and estimating measurements.	F & S, pp. 197-200

Operations	Basic Information	References
Unit VII: Tolerancing	A. Tolerancing	
	1. Purposes of tolerancing.	G. p. 334
	2. Definition of tolerance.	
Students must have a clear understanding of these terms and their purpose.	3. Definitions of terms.	G. p. 336
	4. Fits between mating parts.	
	5. Selective assembly.	G. p. 337
	6. Basic hole system.	
Instructor could prepare information sheets on this material for distribution.	7. Basic shaft system.	G. p. 338
	8. Unilateral tolerances.	G. p. 339
	9. Bilateral tolerances.	
	B. Specification of Tolerances	G. p. 339
	1. Expressing tolerances.	
	2. American Standard limits and fits.	G. p. 341
Students should have practice in locating and interpreting tolerances on drawings. Students should be given drawings which require the placement of tolerance specifications.	3. Running and Sliding fits.	
	4. Locational fits.	G. p. 342
	5. Force fits.	
	6. Accumulation of tolerances.	
	7. Tolerances and shop processes.	G. p. 344
	8. Positional tolerances.	G. p. 345, 346, 347
	9. Maximum material condition.	
	10. Geometric tolerances.	G. p. 348
	11. Bone tolerances for contours.	G. p. 352
	12. Tolerances of angles.	G. p. 353

Operations	Basic Information	References
Unit VIII: Threads, Fasteners and Springs		
	A. Screw Threads	
	1. Definitions of terms.	G. p. 355
	2. Screw-thread forms.	G. p. 356
	3. Thread pitch.	G. p. 357
	4. Right and left hand threads.	
	5. Single and Multiple threads.	G. p. 357
Exercises in drawing threads in detail.	6. Detailed representation of threads.	G. p. 359
	(a) Detailed representation of "V" threads.	G. p. 359
	(b) Detailed representation - square threads.	G. p. 361
	(c) Acme threads.	G. p. 363
	(d) Buttress threads.	G. p. 364
	7. Thread symbols.	
	(a) External thread.	G. p. 364
	(b) Internal thread.	G. p. 365
	(c) Schematic thread symbols.	
Practice drawing schematic threads and threads in section.	8. Threads in section.	G. p. 366
	9. American National Thread.	
	10. American National Thread fits.	
	11. S.A.E. Exta Fine Threads.	G. p. 368
	12. Unified and American Threads.	
Draw detail representation of Unified threads.	13. Unified and American Thread fits.	
	14. Thread notes.	G. p. 369
Practice in placing of thread notes.	15. American Standard Pipe Threads.	G. p. 370

Operations	Basic Information	References
	B. Bolts, Studs and Screws	
	1. Bolt.	G. p. 372
	2. Cap screw.	
	3. Stud.	
	4. Machine screw.	
	5. Set screw.	
	6. Tapped holes.	G. p. 373
	7. American Standard Bolts & Nuts.	G. p. 374
Draw one plate of American Standard bolts.	8. How to draw American Standard Bolts.	G. p. 375
	9. Specifications for bolts and nuts.	
	10. Locknuts and locking devices.	G. p. 378
	11. American Standard Cap Screws.	G. p. 380
	12. American Standard machine screws.	
	13. American Standard set screws.	G. p. 381
	14. American Standard wood screws.	G. p. 383
	C. Miscellaneous Fasteners	
	1. Keys.	G. p. 384
	2. Machine pins.	p. 385
	3. Rivets.	p. 386
	D. Springs	
	1. Definition.	G. p. 387
	2. Types.	
Draw springs in detail, in section and schematic.	3. Method of Drawing. (a) Detailed (b) Schematic	

Operations	Basic Information	References
Unit IX: Intersections and Developments		
	A. Surfaces and Solids	
	B. Intersections of Planes and Solids	G. p. 552
Draw surface development of prismatic forms. (a) right prismatic form (b) oblique prismatic form	1. Developments (a) Characteristics and purposes. (b) Characteristics and kinds of prismatic forms. (c) Geometric construction. (d) Seams and laps.	G. p. 553
Draw the surface development of a truncated prismatic form. (a) right prismatic (b) oblique prismatic	(e) Characteristics of truncated forms. (f) Geometric construction.	
Draw the surface development of a truncated cylindric form.	(g) Characteristics of truncated forms. (h) Geometric construction.	
Find the true length of a line. (a) revolution (b) auxiliary view (c) right triangulation	(i) Purpose of finding the true length of a line. (j) Understand the significance of planes of projection.	F & S, p. 282
Draw the surface development of a pyramidic form. (a) right pyramidic form (b) oblique pyramidic form		
Draw the surface development of a conic form. (a) right conic form (b) oblique conic form	Characteristics and kinds of conic forms.	F & S, p. 284
Find the intersection of two prismatic surfaces.	2. Intersections Meaning and application of the terms; prismatic, intersection, lateral and piercing points.	
Find the intersection of a plane and an oblique cylinder.		G. p. 557

Operations	Basic Information	References
Unit X: Revolutions		
	A. Vertical Axis of Revolution	
	B. Revolution About A Horizontal Axis	F & S, p. 115
	1. Purpose of revolving views.	
Problems F.1, F.2, F.4, F.6, F.19, F.21, G.2	2. Direction of revolution (clockwise or anti-clockwise).	
	C. Finding the True Length of a Line	F & S, p. 118
	D. Finding the True Shape of an Inclined Plane by Double Revolution	
Unit XI: Working Drawings		
	A. Working Drawings	
	1. Description.	F & S, p. 172
Notes on theory.	2. Purpose.	
	B. Detail Drawings	
	1. Definition.	
	2. Purpose.	
	C. Assembly Drawings	F & S, p. 173
	1. Description.	
	2. Purpose.	
	3. Choice of views.	F & S, p. 174
	4. Choice of scale.	p. 175
	5. Grouping and placing parts.	p. 176
	6. Sectional views.	
	7. Rule of contour.	
	8. Rough and finished castings.	F & S, p. 179
	9. Fillets and rounds.	p. 180

Operations	Basic Information	References
	10. Pulleys and flywheels.	
	11. Shafting.	F & S, p. 181, 182, 183
Students complete problems V.1, V.2, V.4, V.6, V.12, V.17, V.25 - F & S, p. 436.	12. Bearings.	
	13. Pipe. (a) Pipe threads and fittings. (b) Sizes of fittings. (c) Piping drawings.	
Unit XII: Reproduction of Drawings		
	A. Introduction	
	1. General purpose of reproducing.	F & S, p. 150, 151
	B. Materials	
	1. Sensitized papers.	
	2. Masters.	
	3. Prints.	
Examples only and general procedure used.	C. Blueprints	
Examples and experience in reproducing prints and tracing.	D. Whiteprints	

MACHINE SHOP 32 OUTLINE

Operations	Basic Information	References
Unit I: Lathe Work		
Advanced turning jobs and projects.	1. Methods of mounting work for eccentric turning.	
	2. Layout procedures.	
	3. Methods of offsetting and of measuring offset.	
	4. Uses of throw blocks.	
	5. Methods of mounting complex castings.	
	6. Principles and practices in counterbalancing.	
	7. Selection of speeds and feeds.	
Turning blanks for gears.	1. Specifications for different types of gears.	
Cutting multiple-start threads; cutting acme, square and buttress threads.	1. Terminology and specifications of various types of threads.	
	2. Gear train calculations.	
	3. Types, designs and selection of single point threading tools.	
	4. Methods of indexing work.	
	5. Methods of cutting odd pitch threads.	
	6. Methods of measuring, testing and gauging threads.	
Winding a spring.	1. Types, features and functions of coil springs.	
	2. Calculations for the making of springs.	
	3. Methods of holding the wire for winding.	

Operations	Basic Information	References
Unit II: Milling		
Milling angular flat surfaces.	1. Methods of mounting work.	
	2. Calculations of angles.	
	3. Methods of measuring flat angles.	
Milling external curved surfaces; milling external irregular surfaces.	1. Methods of roughing down and finishing curved surfaces.	
	2. Methods of laying out irregular shapes.	
	3. Methods of milling to a layout.	
	4. Methods of checking irregular surfaces.	
	5. Use and care of templates.	
Milling helical or spiral grooves.	1. Types and features of helical and spiral grooves.	
	2. Calculation of lead in helix or spiral.	
	3. Methods of checking and testing work.	
Milling spur gears.	1. Design, features and functions of spur gears.	
	2. Calculations for indexing gear blanks.	
	3. Methods of indexing work.	
	4. Methods of finishing gears.	
Unit III: Grinding		
Grinding forming tools.	1. Types, features and characteristics of tools and materials.	
	2. Tool design and angles.	
	3. Methods of forming grinding wheel faces.	
	4. Precautions concerning hand stoning.	
	5. Methods of testing profiles.	

Operations	Basic Information	References
	1. Cutoff grinding wheels.	
	2. Types and features of cutoff grinding wheels.	
	3. Types of work requiring abrasive cutoff.	
	4. Grinding machines: external and internal grinders, surface grinders, centerless grinders.	
Unit IV: Shaping		
Cutting stopped keyways.	1. Layout techniques.	
	2. Ram setting procedures for blind grooves.	
	3. Methods of measuring depth.	
	4. Tool design.	
Shaping external curved surfaces, shaping contours, shaping angular surfaces.	1. Methods of grinding and checking forming tools for curved surfaces.	
	2. Methods of measuring and inspecting curved surfaces, e.g. templates.	
Unit V: Gauges and Gauging	Types of gauges: plug, ring, pin, snap, thread plug and thread ring gauges, indicating type gauges.	
	Fits and tolerances.	
Unit VI: Materials	Hot and cold finished metals, alloy and tool steels, copper and aluminum alloys, bearing metals, cast irons, mechanical properties of metals.	5
Unit VII: General Information		
1. Industrial visits.	1. Employment opportunities.	
2. Speakers from industry and provincial boards.	2. Provincial apprenticeship program	
	3. Workmen's compensation.	
	4. Unemployment Insurance.	
	5. Cost estimating.	

MACHINE SHOP 12, 22, 32

REFERENCE BOOKS

Code

1. METALWORK, TECHNOLOGY AND PRACTICE, Oswald A. Ludwig, McKnight & McKnight Publishing Co.
2. MACHINE TOOL OPERATION, Part I, Burghardt, Axelrod, Anderson, 5th Edition, McGraw-Hill Book Co.
3. MACHINE TOOL OPERATION, Part II, Burghardt, Axelrod, Anderson, 4th Edition, McGraw-Hill Book Co.
4. Apprenticeship Board Publications.
5. MACHINERY'S HANDBOOK, Oberg and Jones, General Publishing Co.
6. SHOP THEORY, Henry Ford Trade School, (Revised Edition), McGraw-Hill.

DRAFTING REFERENCE BOOKS

F	ENGINEERING DRAWING, French and Vierck, 9th Edition, McGraw-Hill Book Company of Canada Ltd., Toronto, Ontario.
F&S	MECHANICAL DRAWING, French and Svenson, and Problem Sheets, Levens and Edstrom, Parts 1 and 2.
G	TECHNICAL DRAWING, Giesecke, Mitchell and Spencer, 4th Edition, Macmillan Company, New York. Canadian Representative, Brett, Macmillan Company, Galt, Ontario.
Z	ENGINEERING DRAWING, Zozzora, McGraw-Hill Book Company of Canada Limited, Toronto, Ontario.
CSA	MECHANICAL ENGINEERING DRAWING STANDARDS, Canadian Standards Association, B78.1.

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